Regeneration Programs Section
Silviculture Branch, 31 Bastion Square, Victoria, B.C. V8W 3E7

February 1994

Regeneration Note 4

Planter Screefs May Increase Frost Heaving

Site

The Sx Trial is located in the SBSwk1 near Tabor Mountain, east of Prince George. The site was broadcast burned in 1991. There were localized hot spots within the burn that resulted in complete removal of humus and exposure of mineral soil. Seedlings were planted in mid May, 1992. The soil texture of the site is silt loam (SiL). The site moisture/nutrient regime is 4(5)–D.

Problem

Frost heaving is a perennial concern in north central British Columbia. The greatest incidence is on moist to wet fine-textured (silt loam–clay) soils. When heaving is severe, growth is affected and seedling mortality may occur. There has been an unacceptably high incidence of frost heaving associated with some boot or shovel screefing, MSP treatments, and late season planting dates.

Frost Heaving

The process that can result in seedlings, primarily container stock, being frost-heaved starts when soil moisture in the surface soil horizon freezes to form an ice lens or thin layer of ice. Soil water in the surface layer expands as it forms ice. The expanding soil surface firmly grips the seedling. The freezing layer draws moisture to it from unfrozen soil layers, causing the ice lens to expand. Further, as the ice lens expands, the surface soil and the seedling are lifted. Upon thawing, the soil collapses, leaving the seedling plug extruded. During fall and early spring, exposed soils can freeze nightly, thawing again the following day. If the seedling is not firmly anchored into the ground by its root system, each freeze–thaw cycle can contribute to the "lifting."

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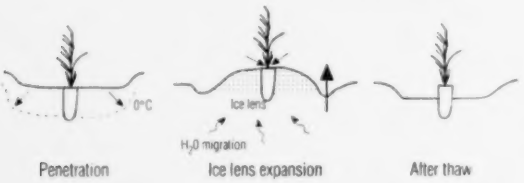
Schematic diagram of frost penetration and heaving of seedling



Frost heaving is determined by many factors. Of particular interest to this trial were:

- soil texture,
- soil moisture, and
- surface characteristics of the screef.

Frost heaving is generally a problem on finer textured soils (silt loam–clay). These soils have a pore size distribution that is ideal for allowing water to be drawn to the freezing front. The hydrological properties of silt make it particularly susceptible to frost heaving when the soil is moist. The size (surface area) and contour of the screef, are important in determining the moisture content and the thermal nature of the soil. Creating depressions around the seedling increases the pooling of moisture in the upper soil layer and the potential for creating larger ice lenses. Exposed mineral soil is much more prone to heaving than soils that are covered with a thin layer of humus or decayed wood.

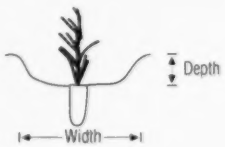
Objective

The objective of this survey was to examine the degree of frost heaving in relation to screef size and depression depth ("planting divot").

Methodology

The original trial was designed to test for differences among fertilization at the time of sowing. During the fall (1992) and spring (1993), many of the seedlings in the trial were frost heaved. The frost heaving appeared to be related to planting rather than to fertilization effects. Seedlings were measured for the amount of frost heaving, the size of the surrounding screef (% mineral soil, humus, coarse woody debris), and the depth of the planting screef.

Schematic diagram of seedling and screef measurements.



Results and Discussion

Frost heaving has been strongly correlated with mechanical and manual site preparation treatments that expose large areas of mineral soil. The influence of screefed depressions has also been recognized as contributing significantly to frost heaving.

In this trial, a strong relationship was identified between the amount of frost heaving, the size of the screef and the presence of a depressed planting screef. The principal contributing factor with screefs was exposed mineral soil. Only screef depressions with depths greater than 5 cm were considered. Screefs and screef depressions were classified as follows:

SS Small screef; <800 cm^2 (25 cm × 30 cm);

SSC Small, screef depression;

MS Medium-sized screef; 800–1500 cm^2 (25 cm × 30 cm–35 cm × 40 cm);

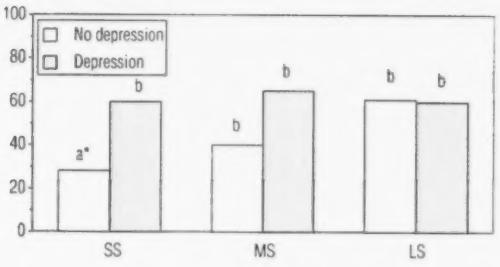
MSC Medium-sized screef depressions;

LS Large screef; >1500 cm^2 (35 cm × 40 cm);

LSC Large screef depressions.

Example of extreme frost heaving showing almost complete extrusion of a PSB 313B 1+0 seedling. Notice the size of the screef and the depth of the planting divot. Notice also that the leader had lost almost all of its needles as a result of dessication.

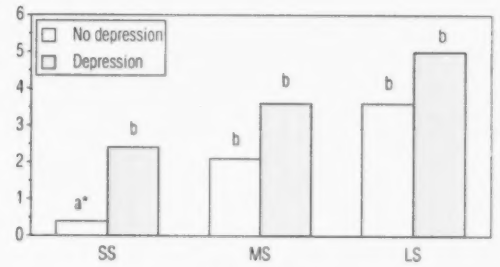
Frost heaving frequency (%)



Screef size

* Values with the same letter are not significantly different; 95% confidence around treatment frequency.

Plug extrusion (cm)



Screef size

* Values with the same letter are not significantly different; 95% confidence around mean.

There were other factors, noted but not measured, that may have contributed to the degree of heaving:

- amount of tamping during planting, or firmness of planting,
- planting depth,
- presence and type of adjacent vegetation,
- proximity of seedling to screef edge, and
- depth of humus or decayed wood.

Conclusions and Recommendations

On sites that are highly prone to frost heaving, the size and form of planting screefs may significantly influence the incidence and severity of frost heaving. On such sites, avoid creating large screefs down to bare mineral soil and minimize depressions around seedlings. When creating small screefs, avoid forming deep depressions. Minimizing the degree of exposure of bare mineral soil around the seedling, while still removing loose humus or decayed wood, will help to avoid frost heaving.

Acknowledgement

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